CONCISE STATEMENT OF RELEVANCE

for

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This invention is a plasma treatment device that supplies a reactant gas to a wafer to improve uniformity of a film-forming speed and therefore improve membrane formation rate.

PATENT ABSTRACTS OF JAPAN

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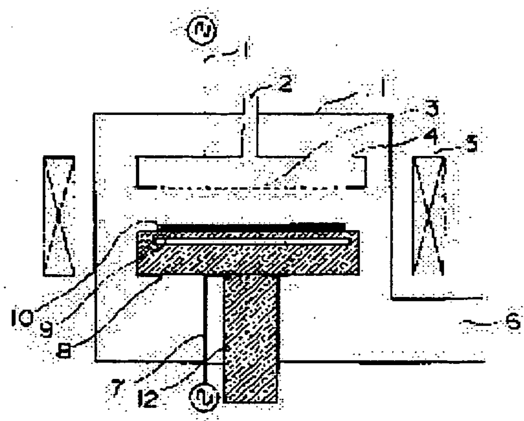
(54) DEVICE AND METHOD FOR PLASMA TREATMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a parallel plate plasma treatment device, which can improve the in-plane uniformity of a film-forming speed by concentrically introducing a film forming gas to 8 spot, where the film forming speed is slow by changing the structures of gas supplying shower nozzles attached to an upper electrode; and to provide a method of plasma treatment.
SOLUTION: The number of the reaction gas supplying shower nozzles, attached to the upper electrode 4 per unit area, is changed in the plane of a wafer 16. In this way, the in-plane uniformity of the film forming speed is improved by concentrically introducing the film-forming gas to the spot, where the film forming speed is slow. In addition, the opening areas of the nozzles are changed in the plane of the wafer 16. Consequently, the in-plane uniformity of the film forming speed is improved, by concentrically introducing the film forming gas by changing the flow rate of the introduced gas in the plane of the wafer 16. In addition, the film-forming speed and the quality of a formed film are improved, by decomposing the film forming gas having low dissociation efficiency by aggressively making the gas to stay in a high-density plasma by not only introducing the nozzles 13 perpendicularly to the wafer 16 placed on a lower electrode 8, but also obliquely to the wafer 16.



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CLAIMS

[Claim(s)]
[Claim 1] The lower electrode which lays a processed base, and the up electrode by which opposite arrangement was carried out with said lower electrode, It is attached in said up electrode surface or said lower electrode surface, and said lower electrode or said up electrode is equipped with two or more gas inlets by which opposite arrangement was carried out. While the numbers per unit area of two or more of said gas inlets differ according to the location within a field of said up electrode Plasma treatment equipment characterized by impressing an electrical potential difference between said lower electrodes and said up electrodes, generating the plasma, and performing predetermined processing to said processed base using this plasma.
[Claim 2] At least one of said the gas inlets is plasma treatment equipment according to claim 1 characterized by having the larger include angle than 90 degrees or the include angle smaller than 90 degrees to a processed base.
[Claim 3] Plasma treatment equipment according to claim 1 or 2 characterized by generating the plasma between said lower electrodes and said up electrodes using magnetron discharge.
[Claim 4] Said plasma is plasma treatment equipment according to claim 3 characterized by performing plasma-CVD processing.
[Claim 5] Plasma treatment equipment according to claim 1 to 4 characterized by connecting to said up electrode or said lower electrode at least one RF generator which has a specific frequency.
[Claim 6] Plasma treatment equipment according to claim 1 to 4 characterized by connecting to said up electrode or said lower electrode two RF generators which have a different frequency.
[Claim 7] Plasma treatment equipment according to claim 1 to 4 characterized by connecting a different RF generator to said up electrode and a lower electrode.
[Claim 8] Said different RF generator is plasma treatment equipment according to claim 7 characterized by having a frequency different, respectively.
[Claim 9] Plasma treatment equipment according to claim 1 to 8 characterized by having the device in which the laid processed base is heated to said lower electrode, the device heated and cooled, or the device to cool.
[Claim 10] The gas installation flow rate of said gas inlet is plasma treatment equipment according to claim 1 to 9 characterized by differing according to the location within a field of said up electrode.
[Claim 11] In the reaction container with which said processed base was held in plasma treatment equipment according to claim 4, it is SiF4 as material gas. 02 Or SiF4 02 And SiH4 The plasma treatment approach characterized by supplying from the nozzle for gas installation, exciting discharge within this reaction container, and making the insulator layer which uses SiO and F as a principal component deposit on said processed base.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention impresses an electrical potential difference to inter-electrode, generates the plasma, and relates to the plasma treatment equipment which performs processing required for a processed base using this plasma, especially relates to plasma-CVD equipment with the high dissociation effectiveness of reactant gas.
[0002]
[Description of the Prior Art] Conventionally, in wafer down stream processing which forms a semiconductor device, the plasma treatment using plasma treatment equipment is one of the important processes. The improvement in the membrane formation rate for example, in CVD processing, membraneous quality and the etch rate in etching processing, an etching configuration, etc. and those homogeneous improvement within a wafer side are very important for the processing using plasma treatment equipment. In parallel monotonous mold plasma treatment equipment, in order to gather processing effectiveness, the densification of the upper part and the lower inter-electrode plasma is called for. For that purpose, it is thought that the increment in a trap of the ion and electron in inter-electrode [by raising the containment-of-plasma effectiveness with ** magnet and raising ** discharge frequency] etc. is effective. It actually turns out that it is effective in the effectiveness of plasma treatment to raise to raise magnet reinforcement from 120 gauss (Gauss) to 320 gauss and a discharge frequency to 60MHz from 13.56MHz. However, if it carries out using assistance of impressing high frequency to an up electrode, and a magnet, it is difficult for the field where a plasma consistency is high, and concentration "electronic ******" to be made in an up electrode surface, and for a bias to arise notably in plasma density distribution between parallel plate electrodes, and to make all inter-electrode fields realize the uniform high density plasma.
[0003] Drawing 8 is the typical outline sectional view of conventional plasma treatment equipment. In drawing, a reaction chamber (chamber) has evacuation opening and is in the airtight condition. The up electrode 104 is attached in the top cover. The magnet for magnetron discharge (not shown) is installed in the chamber side face. The up electrode 104 has the disc-like shower nozzle which has much micropores penetrated on the inferior surface of tongue from a top face. RF generator 101 which impresses high-frequency voltage to the up electrode 104 is formed. The lower electrode 108 is supported with the stanchion. This stanchion is constituted possible [rise and fall], and can change inter-electrode spacing now. In order to maintain heat conduction of the processed substrates 110, such as a silicon wafer, and a substrate supporter on the lower electrode 108, the electrostatic chuck device which carries out the chuck of the processed substrate according to electrostatic force is established. RF generator 107 which impresses high-frequency voltage is formed in the lower electrode 108. The reactant gas supplied is injected and supplied towards a processed substrate from a shower nozzle. The reactant gas supplied in the chamber by the high-frequency voltage impressed from RF generators 101 and 107 is plasma-ized, and plasma treatment of the front face of a processed substrate is carried out by this plasma.
[0004]
[Problem(s) to be Solved by the Invention] The plasma treatment equipment of the type which has such a usual parallel plate electrode Since the shower nozzle which supplies gas to a reaction field has introduced gas in the perpendicular direction to a wafer, If dissociation energy introduces high material gas from an up electrode shower nozzle, since the gas supplied will be perpendicularly introduced to a processed substrate, the time amount to which gas stays at the field where the plasma consistency of the up electrode circumference is high will be restricted, and dissociation of reactant gas cannot fully be performed. Therefore, a sufficient membrane formation rate and membraneous quality cannot be obtained. That is, there was a case where effectiveness of plasma treatment was not gone up even if densification of the plasma is carried out.
[0005] Moreover, in parallel monotonous mold plasma treatment equipment, in order to carry out densification of the inter-electrode plasma, it is thought useful to narrow inter-electrode spacing. However, when it narrowed inter-electrode, it was difficult for the exhaust air engine performance in a wafer core and a periphery to differ, and for differential pressure to arise in a wafer side, and to raise the homogeneity within a field. Moreover, since a wafer periphery hit the periphery of a lower electrode, when it narrowed inter-electrode, it was easy to produce the effect of the heterogeneity of gas or the plasma notably, and the membrane formation heterogeneity of a wafer periphery had barred the improvement in the homogeneity within a wafer side. This invention is made according to such a situation, it changes the structure of the shower nozzle for gas supply attached in the up electrode, introduces gas aslant, introduces membrane formation gas into the low place of a scale and a membrane formation rate for improvement in a membrane formation rate and membraneous quality intensively, and offers the parallel monotonous mold plasma treatment equipment and the plasma treatment approach of aiming at improvement in the ****** - nature of a membrane formation rate.

[0006]
[Means for Solving the Problem] This invention is characterized by carrying out a part of to change the number per unit area of the shower nozzle which supplies the reactant gas attached in the up electrode in a wafer side, to change the opening area of a shower nozzle in a wafer side, and shower nozzle aslant from a perpendicular to a wafer side in parallel monotonous mold plasma treatment equipment. By changing the number of the shower nozzles per unit area in the wafer side which counters, membrane formation gas is intensively introduced into the low place of a membrane formation rate, and improvement in the ****** - nature of a membrane formation rate is achieved. By changing the opening area of a shower nozzle in the wafer side which counters, a gas installation flow rate is changed in a field, membrane formation gas is intensively introduced into the low place of a membrane formation rate, and improvement in the homogeneity within the field of a membrane formation rate is achieved. Moreover, by it not only introducing a shower nozzle perpendicularly, but introducing it aslant to a wafer, make the gas of low dissociation effectiveness stay positively into the high density plasma of the field, gas is made to decompose, and improvement in a membrane formation rate and membraneous quality is achieved.
[0007] Namely, the lower electrode with which the plasma treatment equipment of this invention lays a processed base, It is attached in the up electrode by which opposite arrangement was carried out with said lower electrode, and said up electrode surface or said lower electrode surface. While said lower electrode or said up electrode is equipped with two or more gas inlets by which opposite arrangement was carried out and the numbers per unit area of two or more of said gas inlets differ according to the location within a field of said up electrode An electrical potential difference is impressed between said lower electrodes and said up electrodes, the plasma is generated, and it is characterized by performing predetermined processing to said processed base using this plasma. You may make it at least one of said the gas inlets have a larger include angle than 90 degrees or an include angle smaller than 90 degrees to a processed base. You may make it generate the plasma between said lower electrodes and said up electrodes using magnetron discharge. Said plasma may be made to perform plasma-CVD processing. At least one RF generator which has a specific frequency may be made to be connected to said up electrode or said lower electrode. Two RF generators which have a different frequency may be made to be connected to said up electrode or said lower electrode. A different RF generator may be made to be connected to said up electrode and the lower electrode.
[0008] You may make it said different RF generator have a frequency different, respectively. You may make it have the device in which the laid processed base is heated, the device heated and cooled, or the device to cool in said lower electrode. You may make it the gas installation flow rates of said gas inlet differ according to the location within a field of said up electrode. In the art which performs plasma-CVD processing using said plasma equipment, the plasma treatment approach of this invention in the reaction container with which said processed base was held It is SiF_4 as material gas. O_2 Or SiF_4 O_2 And SiH_4 It is characterized by supplying from the nozzle for gas installation, exciting discharge within this reaction container, and making the insulator layer which uses SiO and F as a principal component deposit on said processed base.
[0009]
[Embodiment of the Invention] Hereafter, the gestalt of implementation of invention is explained with reference to a drawing. First, the 1st example is explained with reference to drawing 1 and drawing 2 . Drawing 1 is the typical outline sectional view of the plasma-CVD equipment of this invention. In drawing, the reaction chamber (chamber) 11 has the evacuation opening 6, and can hold an airtight now. The top cover of the chamber 11 upper part is supporting the up electrode 4. Moreover, the magnet 5 for generating magnetron discharge is installed in the chamber side face. The up electrode 4 has the disc-like shower nozzle which has much micropores 3 penetrated on the inferior surface of tongue from a top face. RF generator 1 which impresses high-frequency voltage is formed in the up electrode 4. The lower electrode 8 is supported with the stanchion 12, and this stanchion is constituted possible [rise and fall], and can change inter-electrode spacing suitably. Moreover, in order to keep temperature constant in the lower electrode 8 installed in the upper part of a stanchion 12, the cooling pipe and heater 9 which are made to circulate through a cooling agent are built in.
[0010] Moreover, in order to maintain heat conduction of the processed substrates 10, such as a silicon wafer, and a substrate supporter on the lower electrode 8, the electrostatic chuck device (not shown) which carries out the chuck of the processed substrate 10 according to electrostatic force is established. The lower electrode 8 is equipped with RF generator 7 which impresses high-frequency voltage through a stanchion 12. The up electrode 4 is connected to the gas supply pipe 2, and the reactant gas supplied in a chamber 11 is injected towards the processed substrate 10 from the micropore 3 of a shower nozzle from the gas supply pipe 2. Drawing 2 is the fragmentary sectional view which expanded micropore 3 part of the shower nozzle shown in drawing 1 . The detailed configuration containing the shower nozzle of space 11in chamber ' between the lower electrode 8 and the up electrode 4 is shown. As shown in drawing 2 , not the nozzle that was perpendicularly suitable to the wafer 16 which is the processed substrate arranged face to face but the nozzle with which whenever [gas fluid inlet angle] was set as the include angle of arbitration in the range from 0 degree to 180 degrees is being used for the shower nozzle 13 for gas supply. The amount of gas installation from the number of the nozzles 13 for gas supply and nozzle per unit area within an up electrode surface is also set as arbitration according to the location in the up electrode surface (namely, inside of the wafer side which counters). For example, the opening area of the shower nozzle 13 is changed and control of the amount of gas installation is possible. Drawing 2 is an example at the time of seting constant the direction of gas supply of the shower nozzle 13, and seting constant the number of the gas nozzles per unit area within the 4th page of an up electrode, and seting constant the amount of gas installation from a gas nozzle.
[0011] Next, actuation of plasma treatment equipment is explained with reference to drawing 1 and drawing 2 . The plasma-CVD membrane formation on which the silicon oxide (low dielectric constant-ized film) which contained fluorine (F) with this processor is made to specifically deposit is explained. First, a chamber 11

is exhausted to a vacuum through an exhaust port 6. Next, after installing the silicon wafer 16 which is a processed base on the susceptor of the lower electrode 8 and heating to desired processing temperature (370 degrees C) using the resistance heating heater 9, the material gas for forming fluoridation silicon oxide (F:SiO2) from the shower nozzle 13 for gas supply is introduced. As material gas, it is SiF4. O2, respectively 100sccm installation is carried out, and it discharges by pressure 30mTorr.20 sccm, and is fluoridation SiO2 with a plasma-CVD method. The film is made to deposit. Discharge is performed by RF generators 1-3000W which impress high-frequency voltage to the up electrode 4. In order to perform sputtering effectively in that case, 300W were made to output to RF generator 7 which impresses a DC bias to a silicon wafer. High-frequency voltage with a frequency of 27.12MHz was impressed to the up electrode 4, and high-frequency voltage with a frequency of 2MHz was impressed to the lower electrode 8. Magnetic reinforcement is 120 gauss (Gauss).

[0012] The plasma field generated in inter-electrode under the above-mentioned conditions turns into the high density plasma field 14 and the low consistency plasma field 15, as shown in drawing 2 . The high density plasma field 14 is concentrated on about four up electrode, and the low consistency plasma field 15 is formed in about 16 silicon wafer. Here, since the gas inflow direction is perpendicularly and slanting to the field where a wafer 16 counters, the time amount put to the high density field 14 until gas reaches a wafer 16 becomes long. If gas is perpendicularly introduced to a wafer 16, the time amount put to the high density field 14 until gas reaches a wafer 16 will become small rather than it introduces aslant. Therefore, it is SiF4 with low dissociation effectiveness by the operation to which the time amount put to a high density field until it reaches this wafer becomes long. The dissociation effectiveness of gas improves and fluoridation silicon oxide accumulates efficiently. Thus, by changing the gas installation direction according to the dissociation effectiveness in the inside of the plasma of the gas introduced in a chamber, the decomposition effectiveness of gas until it reaches a wafer (low consistency plasma field) improves, and a membrane formation rate improves. As a result of experimenting on the above-mentioned membrane formation conditions, the gas installation direction used the perpendicular nozzle to the wafer altogether, and improvement in about 30% of membrane formation rate was checked as compared with the conventional experimental result performed on the same membrane formation conditions.

[0013] Moreover, as a result of experimenting on the above-mentioned membrane formation conditions, when fluorescence X rays estimated the atomic composition ratio under membrane formation, the fluoridation silicon oxide (SiO2) in accordance with stoichiometric composition was formed. Moreover, when FT-IR measurement of the film of (Fluorine F) concentration 12.0 atom % extent was carried out after one week of membrane formation, the joint peak of Si-OH of the 3800cm-1 neighborhood which shows what moisture was absorbed for during membrane formation, and H-OH was not seen. If membranous stability is taken into consideration from a hygroscopic viewpoint, it will be considered ** by very stable fluoridation silicon oxide. Thus, it becomes possible to obtain the sufficient membrane formation rate and the membraneous quality of the deposition film with plasma-CVD equipment. With the conventional approach, it is SiF4. SiO2 which existed while Si more superfluous than Si atomic number expected when it is stoichiometric composition when sufficient dissociation of gas is not performed but fluorescence X rays estimate the atomic composition ratio in the film formed membranes, and added the same F concentration The rise of specific inductive capacity was caused as compared with the film. The joint peak of Si-OH of the 3800cm-1 neighborhood which shows what moisture was absorbed for during membrane formation in the film of F concentration 12.0 atom % extent when FT-IR measurement was performed after one week of membrane formation, and H-OH was seen. If membranous stability is taken into consideration from a hygroscopic viewpoint, it will be considered the very unstable film.

[0014] In addition, SiH4 O2 Gas or SiF4 O2 And SiH4 The same effectiveness was acquired also by gas. Moreover, by carrying out the seal of approval of the high-frequency voltage of a different frequency from the high-frequency voltage of RF generator 1 to the up electrode 4 showed that there was an improvement of a membrane formation rate further. Moreover, by carrying out the seal of approval of the high-frequency voltage of a different frequency from the high-frequency voltage of RF generator 7 to the lower electrode 8 showed that the improvement of membraneous quality could be aimed at further.

[0015] Next, the 2nd example is explained with reference to drawing 3 . Drawing 3 is the fragmentary sectional view which expanded micropore 3 part of the shower nozzle shown in drawing 1 . That is, the detailed configuration containing the shower nozzle of space 11in chamber ' between the lower electrode 8 and the up electrode 4 is shown. as shown in drawing 3 , the nozzle to which the include angle of not only the nozzle that was perpendicularly suitable to the silicon wafer 20 which is the processed substrate arranged face to face but arbitration was resembled, and whenever [gas fluid inlet angle] was set in the range from 0 degree to 180 degrees is being used for the shower nozzle 17 for gas supply. The amount of gas installation from the number of the nozzles 17 for gas supply and nozzle per unit area within an up electrode surface is also set as arbitration according to the location in the up electrode surface (namely, inside of the wafer side which counters). For example, the opening area of the shower nozzle 17 is changed and control of the amount of gas installation is possible. In the example shown in drawing 3 , although an include angle is changed into arbitration for the gas installation direction or the direction of gas supply in a part for a core and the circumference part of the up electrode 4 using the shower nozzle 17 for gas supply attached in the up electrode 4, it becomes possible.

[0016] By changing the gas installation direction or the direction of gas supply like this example according to the dissociation effectiveness in the inside of the plasma of the reactant gas introduced in a chamber, the decomposition effectiveness of gas until it arrives at a silicon wafer or the low consistency plasma field 19 (it is the high density plasma field 18 near the up electrode) improves, and a membrane formation rate improves.

[0017] Next, the 3rd example is explained with reference to drawing 4 . Drawing 4 is the fragmentary sectional view which expanded micropore 3 part of the shower nozzle shown in drawing 1 . That is, the detailed configuration containing the shower nozzle of space 11in chamber ' between the lower electrode 8

and the up electrode 4 is shown. As shown in drawing 4 , the shower nozzle 21 for gas supply is perpendicularly suitable to the silicon wafer 24 which is the processed substrate arranged face to face, and the opening area of changing the number per unit area within the field of the up electrode 4 by the location or the shower nozzle 21 is changed by the location. The high density plasma field 22 is formed in about four up electrode, and the low consistency plasma field 23 is formed near the lower electrode 8 and the wafer 24. The opening area of the shower nozzle 21 is changed and the amount of gas installation is controlled. In order to make [many] the amount of gas installation, by enlarging magnitude of the opening area of enlarging the number per unit area of the shower nozzle 21, or the shower nozzle 21 by the periphery compared with the core of the up electrode 4, the distribution property of the membrane formation rate not only in an improvement of a membrane formation rate but the silicon wafer 24 whole surface improves, and a membrane formation rate equalizes as compared with the case where the gas inlet of the conventional structure is used.
[0018] Next, the 4th example is explained with reference to drawing 5 thru/or drawing 7 . The up electrode top view of the plasma treatment equipment with which, as for the outline sectional view of the plasma treatment equipment of this invention where drawing 5 is typical and the expanded sectional view of A part of this sectional view, and drawing 6 , the shower nozzle has been arranged, and drawing 7 are the top view showing other examples of the up electrode of the plasma treatment equipment with which the shower nozzle has been arranged, and the expanded sectional view of B part of this top view. For example, as shown in drawing 2 , the high density plasma field 14 concentrates the upper part and the lower inter-electrode plasma field which are generated by impression of high-frequency voltage to reactant gas near the up electrode 4, and it has become the low consistency plasma state (15) near the lower electrode 8. This high density plasma field 14 is drawn so that it may be uniform thickness, but in practice, the chamber periphery section has an exhaust port etc., and since the pressure is low, plasma discharge effectiveness is getting [the high density plasma field 14] worse therefore in the configuration where a periphery is thin. With the plasma treatment equipment shown in drawing 5 , the distance between the lower electrodes 48 of the up electrode 44 periphery section is shorter than the distance between the lower electrodes 48 of the inner circumference section corresponding to the configuration of the above-mentioned high density plasma treatment field. That is, the field where the up electrode 44 counters with a wafer 42 has dented the center in the shape of a concave lens.
[0019] In drawing 5 (a), a reaction chamber (chamber) has evacuation opening and is in the airtight condition. The up electrode 44 is attached in the top cover. The magnet for magnetron discharge (not shown) is installed in the chamber side face. The up electrode 44 has the disc-like shower nozzle which has much micropores penetrated on the inferior surface of tongue from a top face. RF generator 41 which impresses high-frequency voltage to the up electrode 44 is formed. The lower electrode 48 is supported with the stanchion. This stanchion is constituted possible [rise and fall], and can change inter-electrode spacing now. A silicon wafer 42 is laid on the lower electrode 48, and in order to maintain heat conduction with a substrate supporter, the electrostatic chuck device which carries out the chuck of the silicon wafer according to electrostatic force is established. Moreover, RF generator 47 which impresses high-frequency voltage is formed in the lower electrode 48. The reactant gas supplied is injected and supplied towards a processed substrate from a shower nozzle. The reactant gas supplied in the chamber by the high-frequency voltage impressed from RF generators 41 and 47 is plasma-ized, and plasma treatment of the front face of a silicon wafer is carried out by this plasma.
[0020] The plasma treatment equipment of the type which has the conventional parallel plate electrode Since the shower nozzle which supplies gas to a reaction field has introduced gas in the perpendicular direction to a wafer, If dissociation energy introduces high material gas from an up electrode shower nozzle, since the gas supplied will be perpendicularly introduced to a wafer, the time amount to which gas stays at the field where the plasma consistency of the up electrode circumference is high will be restricted, and dissociation of reactant gas cannot fully be performed. Therefore, a sufficient membrane formation rate and membraneous quality cannot be obtained. That is, there was a case where effectiveness of plasma treatment was not gone up even if densification of the plasma is carried out. Moreover, in parallel monotonous mold plasma treatment equipment, in order to carry out densification of the inter-electrode plasma, it is thought useful to narrow inter-electrode spacing. However, when it narrowed inter-electrode, it was difficult for the exhaust air engine performance in a wafer core and a periphery to differ, and for differential pressure to arise in a wafer side, and to raise the homogeneity within a field. Moreover, since a wafer periphery hit the periphery of a lower electrode, when it narrowed inter-electrode, it was easy to produce the effect of the heterogeneity of gas or the plasma notably, and the membrane formation heterogeneity of a wafer periphery had barred the improvement in the homogeneity within a wafer side.
[0021] Then, in this example, as shown in drawing 5 (b), in order to lengthen stay of the reactant gas supplied, the amount of point uses the perpendicular of a wafer and the shower nozzle 45 with an include angle which have not countered at right angles to a wafer 42, and a wafer and the shower nozzle 43 which counters a perpendicular. The shower nozzle 45 to which the tip had the perpendicular and include angle of the wafer suitable for the interior of a wafer 42 in the circumference part of the up electrode 44 is formed, and the shower nozzle 43 which counters a wafer and a perpendicular is formed in the interior from this. Drawing 6 is the top view of the field which counters the wafer of this up electrode. Arrangement formation of the shower nozzles 43 and 45 is carried out at equal intervals concentric circular. Moreover, the high density plasma field formed in inter-electrode of the arrangement structure of this shower nozzle is thickly formed in homogeneity in every field of an up electrode. In this example, as shown in drawing 7 , in consideration of the configuration of a shower nozzle, and arrangement, a still more uniform high density plasma field can be formed.
[0022] This plasma treatment equipment has the lower electrode 58 with which the up electrode 54 and this equipped with the shower nozzles 51, 52, and 53 were countered, for example, the silicon wafer 55 was laid. In order to make [many] the amount of gas installation, the circumference part of the up electrode 54

makes [many] the number per unit area of the shower nozzle 51, and enlarges opening area of the shower nozzle 51, and it is changing the include angle into arbitration in a part for a core, and the circumference part so that the direction of the interior of the up electrode 4 may be turned to for the gas installation direction or the direction of gas supply of the shower nozzle 51. The shower nozzle 53 for a core has countered almost at right angles to a wafer 55. By changing the gas installation direction or the direction of gas supply like this example according to the dissociation effectiveness in the inside of the plasma of the reactant gas introduced in a chamber, the decomposition effectiveness of gas until it arrives at a silicon wafer or a low consistency plasma field improves, and a membrane formation rate improves. By enlarging magnitude of the opening area of enlarging the number per unit area of a shower nozzle, or a shower nozzle by the periphery compared with the core of an up electrode, the distribution property of the membrane formation rate not only in an improvement of a membrane formation rate but the silicon wafer 55 whole surface improves, and a membrane formation rate equalizes as compared with the case where the gas inlet of structure is used conventionally like drawing 8 .

[0023] As mentioned above, if it narrows inter-electrode as each example explained, a wafer periphery will receive the heterogeneity of gas or the plasma and the distribution property of a membrane formation rate will worsen. So, when membranes are formed on the silicon wafer of the diameter of 8 inch by enlarging whenever [gas installation vectorial angle], enlarging the number per unit area of a shower nozzle, enlarging opening area of a shower nozzle by the periphery of an up electrode, and increasing a gas installation flow rate, if dispersion in the membrane formation rate within a field showed with deflection, what was 5 will have been improved by 2. Moreover, it became possible to also control F concentration after membrane formation by the core and circumference part of a silicon wafer to 12.0 atom %, and the variation in the membrane formation membraneous quality in a field decreased.

[0024]

[Effect of the Invention] This invention can introduce membrane formation gas into the low place of a membrane formation rate intensively by the above configuration by changing the number of the shower nozzles per unit area of an up electrode in a field. A gas installation flow rate is changed in a field by changing the opening area of a shower nozzle in a field. By it not only introducing perpendicularly the shower nozzle which can introduce membrane formation gas intensively, but introducing it into the low place of a membrane formation rate aslant to a wafer The gas of low dissociation effectiveness is made to stay positively into the high density plasma, and a membrane formation rate, improvement in membraneous quality, and improvement in the distribution property in those whole silicon wafer surfaces are realized by operation of being able to decompose gas.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The typical outline sectional view of the plasma-CVD equipment of this invention.
[Drawing 2] The fragmentary sectional view which expanded micropore 3 part of the shower nozzle shown in drawing 1 .
[Drawing 3] The fragmentary sectional view which expanded micropore 3 part of the shower nozzle shown in drawing 1 .
[Drawing 4] The fragmentary sectional view which expanded micropore 3 part of the shower nozzle shown in drawing 1 .
[Drawing 5] The typical outline sectional view of the plasma treatment equipment of this invention, and the expanded sectional view of A part of this sectional view.
[Drawing 6] The up electrode top view of the plasma treatment equipment with which the shower nozzle of this invention has been arranged.
[Drawing 7] The top view showing other examples of the up electrode of the plasma treatment equipment with which the shower nozzle of this invention has been arranged, and the expanded sectional view of B part of this top view.
[Drawing 8] The outline sectional view of conventional plasma treatment equipment.
[Description of Notations]
1, 7, 41, 47,101,107 ... An RF generator, 2 ... Gas supply pipe 3 [5 / 8, 48, 58,108 ... A lower electrode, 9 ... Heater, / ... A magnet 6 ... Exhaust port] ... Micropore, 4, 44, 54,104 ... Up electrode 10, 16, 20, 24, 42, 55,110 ... Wafer (processed substrate), [12 / ... A high density plasma field, 15 19, 23 / ... Low consistency plasma field / ... A stanchion, 13, 17 43, 45, 51, 52, 53 ... A shower nozzle 14, 18, 22] 11 ... A reaction chamber (chamber), 11' ... Space in a chamber

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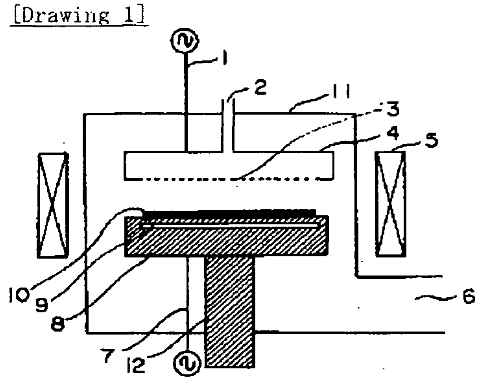
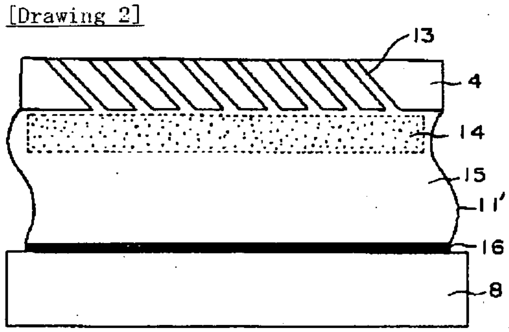
[Translation done.]

DRAWINGS

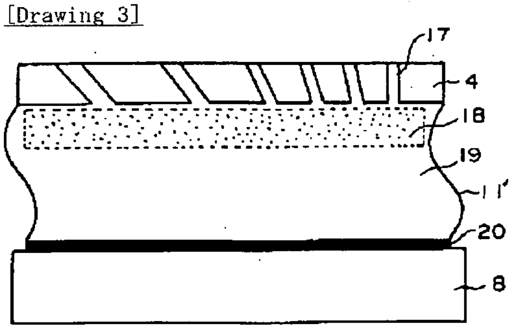
[Drawing 1]



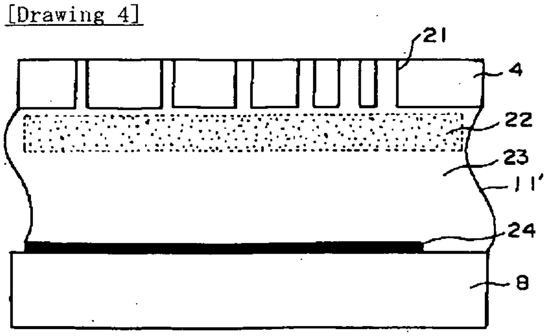
[Drawing 2]



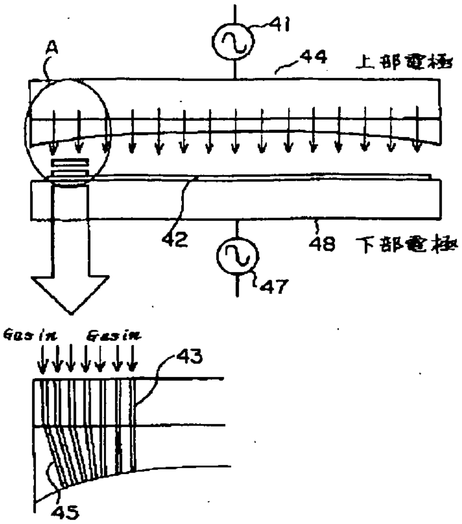
[Drawing 3]



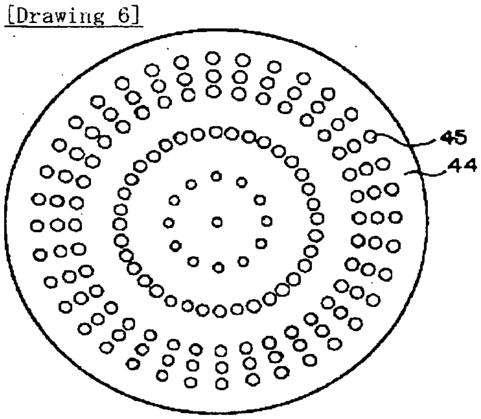
[Drawing 4]



[Drawing 5]



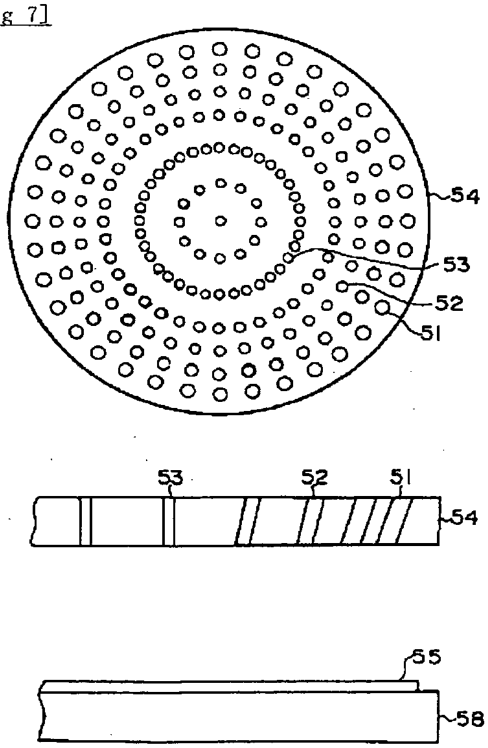
[Drawing 6]



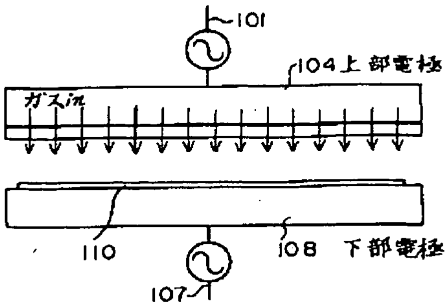
[Drawing 7]

(a)

(b)



[Drawing 8]



[Translation done.]